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Studies on the Physico-chemical Parameters and Correlation Coefficient of the River Ganga at Holy Place Shringverpur, Allahabad

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Abstract: *In the present investigation the physico-chemical parameter of the River Ganga at Shringverpur , Allahabad were analyzed. The analysis of water sample were taken during January 2013– December 2013. Seasonal variations at different sampling sites of Shringverpur were observed. The results shown that the fluctuation occurred in physico-chemical parameter in different seasons. Correlation coefficient value indicates high positive and negative relationships ($p<0.01$ level) and also show significant positive and negative relationship ($p<0.05$ level). About 16 physico-chemical parameter were taken in consideration for analysis of the River water such as water temperature, Total Hardness, Total Alkalinity, pH, Total solids, Dissolved oxygen, Biological oxygen demand, chemical oxygen demand, Transparency, Turbidity, Electrical conductivity, Sulphate, Nitrate, Phosphate, Chloride and Salinity. This paper deal with the study of river Ganga at Allahabad. From Allahabad the sites were taken Shringverpur that were located at 40km distance from Allahabad main city.*

Key words: *Physico-chemical parameters , Shringverpur, Correlation coefficient.*

I. Introduction

Water pollution is a major problem in rivers of India. The crowding of population in urban area is a major cause of polluting the River Ganga. The urban city that are present neighboring to the River Ganga accelerate more pollution to the River Ganga due to the inadequate urban waste management, poor waste management by industries , mass bathing activities during festivals, intensive use of chemical fertilizers. The Water is an essential constituent for the life of human beings as well as for our ecosystem. Without water existence of life on earth are not possible, human and other living organism die , agricultural activities not initiated, business also can not be operated. The physical and chemical parameters exert their influence both, individually and collectively and their interaction creates a biotic environment, which ultimately conditions the origin, development and finally succession of the biotic communities (Salaskar and Yeragi, 1997).The Ganga river water of Shringverpur area is used for domestic as well as agricultural purpose. And this sites are also used as cremation centre by adjoining areas and also used as mass bathing place in terms of secularism. The sewage are also transferred to the Ganga water directly or indirectly by agricultural field due to flooding. The fertilizers used in agricultural fields are also transferred to the Ganga water during flooding. There are generally three types of pollution defined in water i.e. domestic , agricultural and industrial. The industrial as well as municipal pollution can be eradicated. But pollution from agricultural runoff cannot be eradicated easily. Because pollution from agricultural runoff were nonbiodegradable, and this reaches to various tropic level characteristics may describe the quality of water. Physico-chemical and micro-biological characteristics may describe the quality of water. (Sinha, 1986)

Therefore, an analysis on physico-chemical parameters of Ganga water was made by many workers (Mehrotra, 1990;. Sinha et.al. 2000). The correlation coefficient are method by which we can measure the strength of a relationship among variables. The correlation helps in the study of existence and magnitude of the direction of the relation between two or more variables of living organism where they created associated disease in living organism. In the present work the attempt was made to analyze the physicochemical properties (Temperature, pH, DO, Free , TDS, Transparency, Total Alkalinity, Total Hardness, Ca, Mg, Sulphate, Phosphate, Nitrate, BOD, COD) of different sites of Shringverpur at Allahabad to understand the pollution status of water sample.

The tributaries of the River Ganga in India passes through states of Uttarakhand , UttarPradesh, Rajasthan, Madhya Pradesh, Bihar, Jharkhand and West Bengal. The major problem of water pollution comes from anthropogenic activities like discharges of sewage effluents, waste water from houses ,toxic metals as well as metal chelates from different sources and also indiscriminate use of heavy metal containing fertilizers and pesticides in agriculture. The pollution level of water affects the species composition, abundance, productivity

and physiological condition of aquatic communities. Rivers plays a major role in transportation and distribution of materials. The deposition of these materials makes water unsafe for aquatic life and human uses. Assessment of water is necessary for protection and restoration of quality of water. The considerable concern was given to tremendous increase industrial activity and release of obnoxious industrial wastes into the environment. Domestic discharge into the River Ganga not much more problem of polluting the River Ganga, but problem mainly the overloading of urbanization and industrialization. Due to this self tolerance limit of the river Ganga was not sufficient to removing pollution. Due to rapid industrialization, urbanization and population explosion the problem of water pollution has disturbed the environment of water bodies in the last few decades. Harmful consequences of pollutants in aquatic ecosystem are often not detected at early stages. Every citizen should be have prime responsibility for the maintenance of ecological and environment purity. If the people realize and understand the importance of environmental pollution the situation of water quality can improve. The Biotic components of an aquatic system constituted by sediments of river waters. River sediments acts as a source for assessment of contamination in river waters. Singh and Rai (2003) studied the impact of the industrial effluents and domestic sewage on river Ganga at Allahabad and reported that all the pollution parameters are beyond the permissible limits and unfit for human consumption.

II. Experimental Methodology

The water sample were taken from different sampling site of Shringverpur viz., Station 1 (South side), Station 2 (East side), Station 3(North side) and station 4 (West side). in the early morning between 8 am to 11 am in the first week of every month from January – December 2013.

Triplicate samples each of two liters in acid washed five liter plastic containers were collected between 8 A.M. to 10 A.M. from sampling site in the first week of every month from January –December 2013. The water samples taken from a depth of 5-10 cm below the surface of water. And samples were brought to the laboratory in ice boxes for the analysis of various physico-chemical parameters. The physico-chemical characteristics of the dam water like water temperature, turbidity, transparency, pH, Electrical conductivity, total solids (TS), total hardness, alkalinity, chloride, phosphate and nitrate were determined in summer, monsoon and winter according to standard methods (APHA, 2005 and R.K. Trivedy, and P.K. Goel, 1984.)

Table 1: Seasonal variation in Physico-chemical parameter at Shringverpur Dam during the year (Jan 2013 to dec.2013)

parameter	Summer	C.V.%	Monsoon	C.V.%	Winter	C.V.%	Average	C.V.%
Wt ($0^{o}c$)	31.16±0.46	1.47	28.43±5.68	19.97	20.16±0.5	2.48	26.58±5.72	21.51
Total Hardness (mg/l)	202.6±11.84	5.84	231.3±3.05	1.31	220±5	2.27	217.9±14.45	6.63
Alkalinity (mg/l)	176.6±5.13	2.9	156.3±30.1	19.25	129.6±2.51	1.9	154.1±23.57	15.29
PH	8.76±0.15	1.71	7.53±0.05	0.66	7.33±0.05	0.68	7.87±0.77	9.78
Total solids (mg/l)	325.6±12.89	3.9	411.3±13.42	3.26	384.3±2.08	0.54	373.7±43.81	11.72
DO (mg/l)	7.6±0.81	10.65	6.76±0.15	2.21	7.7± 0.3	3.89	7.35±0.516	7.02
BOD (mg/l)	5.53±0.25	4.52	5.13±0.45	8.77	5.43±0.05	0.92	5.36±0.208	3.88
COD (mg/l)	36.4±2.7	7.41	29.53±1.44	4.87	32.66±0.47	1.43	32.86±3.43	10.43
Trans (cm)	28±0.2	0.71	18.6±0.51	2.74	23.5±0.1	0.42	23.36±4.7	20.11
Turbidity (NTU)	41.33±2.51	6.07	63.66±10.4	16.33	28.66±1.52	5.3	44.55±7.72	39.77
Ec (□mhos /cm)	490±7.54	1.53	488±13.22	2.7	454.3±20.3	4.46	477.4±20.05	4.19
Sulphate (mg/l)	25±5	20	21.33±3.05	14.29	18.33±1.52	8.29	21.55±3.34	15.49
Nitrate (mg/l)	0.35±0.0	11.42	0.81±0.01	1.23	0.58±0.02	3.44	0.58±0.23	39.65
Phosphate (mg/l)	0.27±0.025	9.25	0.75±0.026	3.46	0.42±0.1	23.8	0.48±0.24	50
Chloride (mg/l)	81.36±3.84	4.71	64.73±4.26	6.58	43.36±2.89	6.66	63.15±19.04	30.15
Salinity (mg/l)	148.9±6.41	4.3	119.3±8.1	6.78	79.5±5.31	6.67	115.9±34.82	30.06

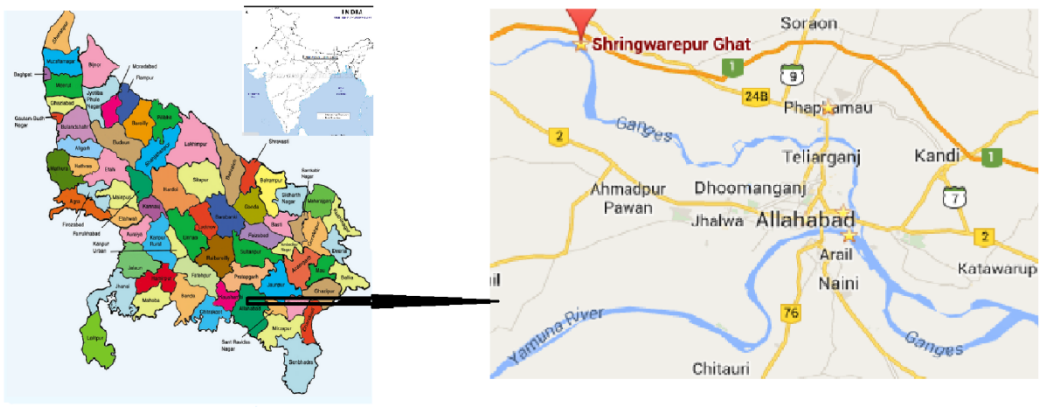
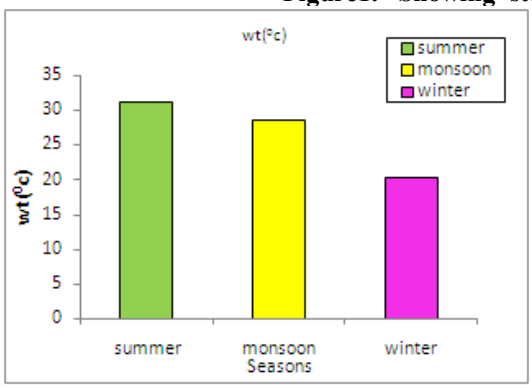
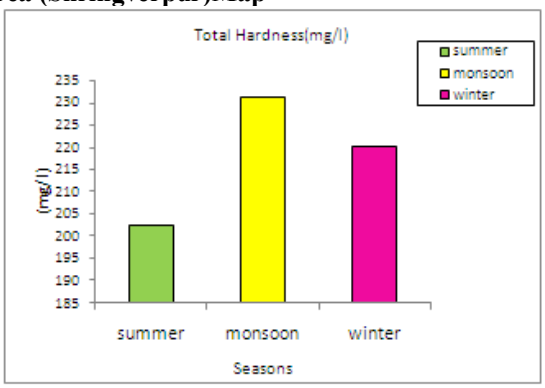


Figure1. Showing study area (Shringverpur)Map



A



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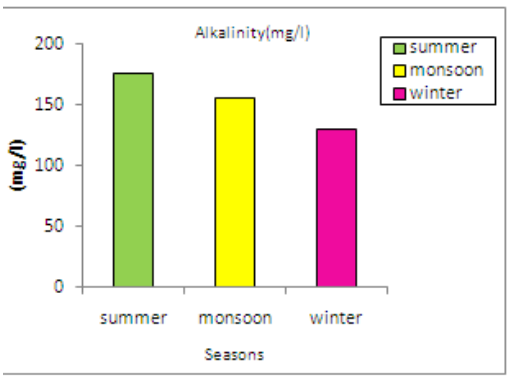

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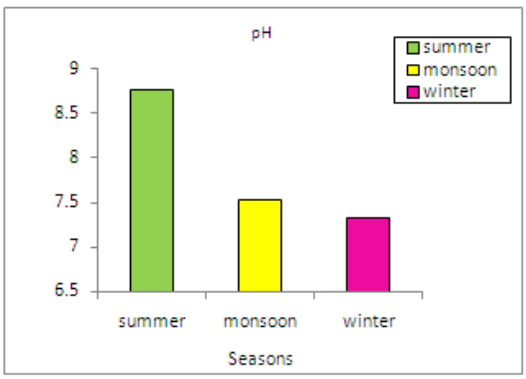

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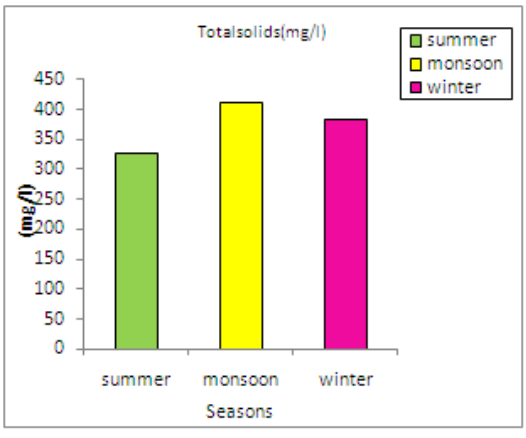

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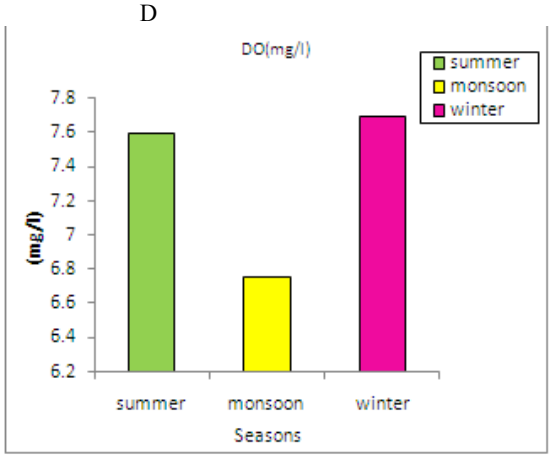

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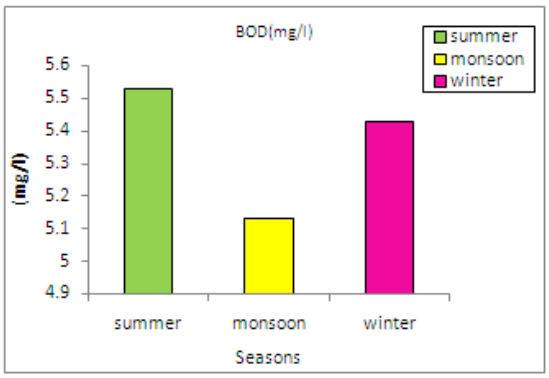
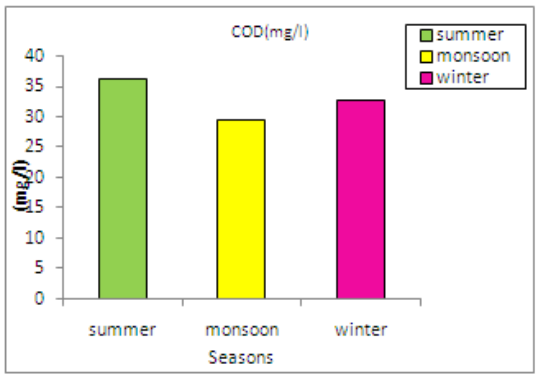
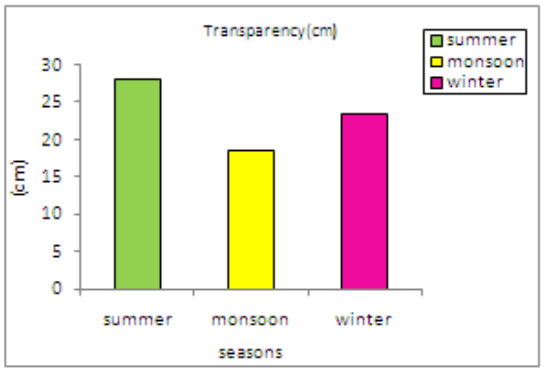

BOD(mg/l)
summer
monsoon
winter
(mg/l)
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
summer
monsoon
winter
Seasons

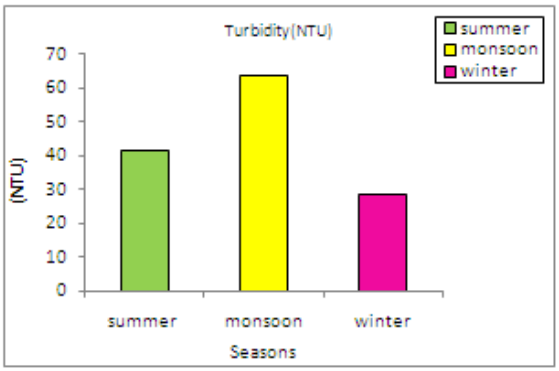
G


COD(mg/l)
summer
monsoon
winter
(mg/l)
40
35
30
25
20
15
10
5
0
summer
monsoon
winter
Seasons

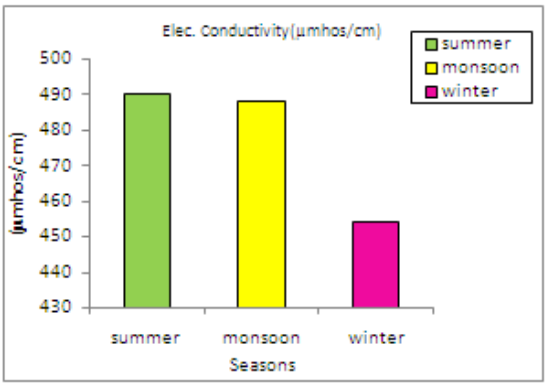
H


Transparency(cm)
summer
monsoon
winter
(cm)
30
25
20
15
10
5
0
summer
monsoon
winter
seasons

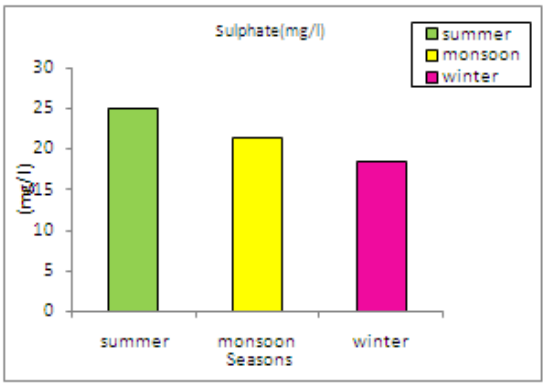
I


Turbidity(NTU)
summer
monsoon
winter
(NTU)
70
60
50
40
30
20
10
0
summer
monsoon
winter
Seasons

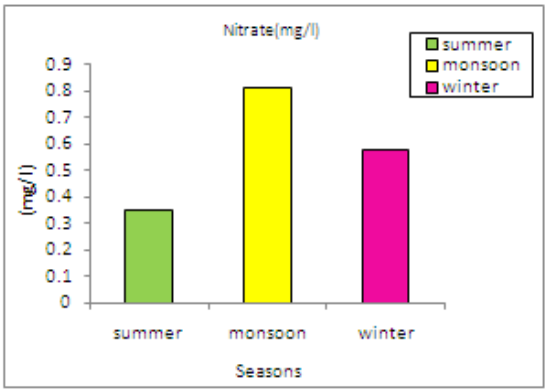
J


Elec. Conductivity(µmhos/cm)
summer
monsoon
winter
(µmhos/cm)
500
490
480
470
460
450
440
430
summer
monsoon
winter
Seasons

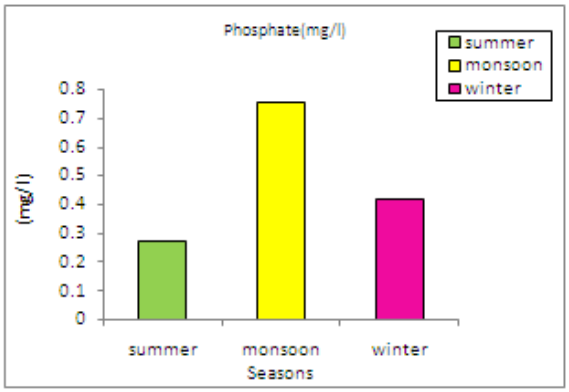
K


Sulphate(mg/l)
summer
monsoon
winter
(mg/l)
30
25
20
15
10
5
0
summer
monsoon
winter
Seasons

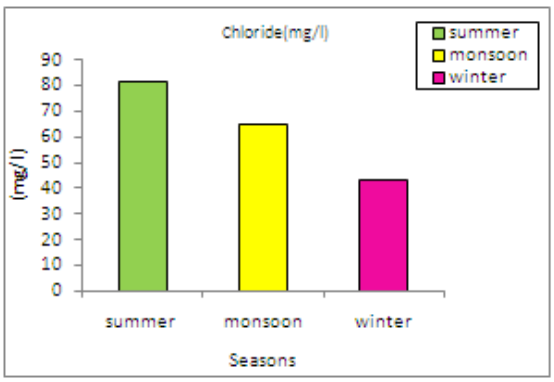
L


Nitrate(mg/l)
summer
monsoon
winter
(mg/l)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
summer
monsoon
winter
Seasons

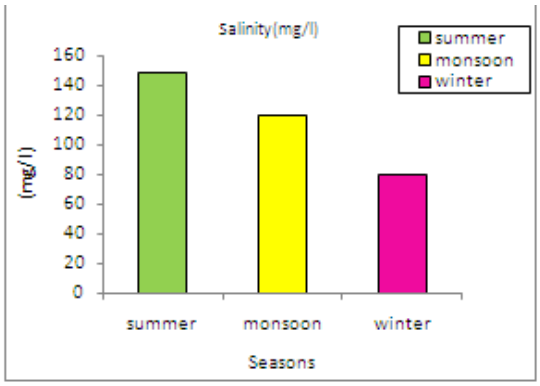
M


Phosphate(mg/l)
summer
monsoon
winter
(mg/l)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
summer
monsoon
winter
Seasons

N



O



P

Fig. 1: Graphs showing average seasonal variations of four sties in Water temperature, Turbidity, Transparencey,pH, Electric conductivity, Total Solids, Alkalinity, Total hardness, Sulphate, Chloride Nitrate and phosphate (A to P) at different seasons of Shringverpur dam, Allahabad [U.P.] India. (During January - December 2013).

Table 2: Correlation matrix among the physico-chemical parameter of river Ganga at Shringverpur from January 2013 to December 2013

Parameter	Wt (0^0c)	Hardness (mg/l)	Alkalinity (mg/l)	pH	Ts (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	Tra (c.m.)	Tur (ntu)	Ec (□mhos /cm)	Sulphate (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	Chloride (mg/l)	Salinity (mg/l)
W.t.(0^0C)	1															
Total Hardness (mg/l)	-.355	1														
Alkalinity (mg/l)	.979**	-.537	1													
PH	.779**	-.862**	.890**	1												
Total solids (mg/l)	-.436	.996**	-.610*	-.904**	1											
DO (mg/l)	-.371	-.737**	-.175	.293	-.674*	1										
BOD (mg/l)	-.040	-.920**	.163	.595	-.882**	.943**	1									
COD (mg/l)	-.288	-.997**	.476	.824**	-.987**	.783*	.945**	1								
Tra (cm)	-.214	-.989**	.408	.779**	-.973**	.828**	.967**	.997**	1							
Turbidity (NTU)	.604*	.531	.430	-.029	.454	-.964**	-.821**	-.589	-.649*	1						
E.C.(□mhos /cm)	.982**	-.171	.923**	.646*	-.257	-.540	-.229	.101	.025	.744**	1					
Sulphate (mg/l)	.942**	-.647	.991**	.944**	-712**	-.039	.296	.591	.529	.303	.862**	1				
Nitrate (mg/l)	-.238	.993**	-.431	-.794**	.978**	-.814**	-.961**	-.999**	-1.000	.630*	-.050	-.549	1			
Phosphate (mg/l)	-.027	.944**	-.230	-.648*	.912**	-.918**	-.998**	-.965**	-.982**	.780*	.163	-.360	.977**	1		
Chloride (mg/l)	.978**	-.543	1.000	.893**	-.615*	-.168	.170	.482	.414	.424	.920**	.992**	-.437	-.236	1	
Salinity (mg/l)	.980**	-.532	1.000	.888**	-.605*	-.181	.157	.471	.403	.435	.925**	.990**	-.425	-.224	1.000	1

**= Correlation is high significant at p < 0.01 level, '-' indicate negative correlation,*= Correlation is significant at p < 0.05,

W.T = Water temperature, Ts= Total solids ,DO= Dissolved Oxygen , BOD= Biological Oxygen Demand, COD= Chemical Oxygen Demand, Tra= Transparency, E.C.= Electrical conductivity,

III. Results and Discussion

Water temperature

The physico-chemical analysis of the ganga river water indicate that water temperature ranged minimum in winterof 20.16±0.5 mg/l and maximum in summer of 31.16±0.46 mg/l Results indicate that higher temperature were recorded in summer lowest in winter whereas intermediate in monsoon season. The overall mean was 26.58±5.72 mg/l and coefficient variation was 21.51.The rate of microbial activity increased with increase in temperature. Water temperature show high significant positive relationship with salinity,chloride, sulphte, electrical conductivity, alkalinity and pH. where as positve relationship with turbidity.

Total hardness

The total hardness value was recorded higher in monsoon of 231.3± 3.05 mg/l and lower in summer of 202.6±11.84 mg/l . Results indicate that higher total hardness was observed in monsoon season

lower in summer whereas intermediate in winter season. The overall mean was 217.9±14.45 mg/l and coefficient variation was 6.63. Total hardness show high significant positive relationship with total solids,nitrate and phosphate whereas high significant negative relationship with pH,DO, BOD,COD, and Transparency.

Total alkalinity

The Total Alkalinity value was observed maximum in summer of 176.6±5.13 mg/l and minimum was observed in winter of 129.6±2.51 mg/l . Results indicate that higher total alkalinity was observed in summer lower in winter whereas intermediate value were observed in monsoon season. The overall mean was 154.1±23.57 mg/l and coefficient variation was15.29. Alkalinity show high significant positive relationship with water temperature, pH, electrical conductivity and sulphate. Whereas significant negative relationship with total solids.

pH

The pH value was observed maximum in summer of 8.76±0.15 and minimum was observed in winter of 7.33±0.05 Results indicate that higher pH was observed in summer lower in winter whereas intermediate value were observed in monsoon season. The overall mean was 7.87±0.77 and coefficient variation was 9.78. pH show high significant positive relationship with water temperature , alkalinity , cod, transparency salinity,chloride, sulphte, electrical conductivity, alkalinity and pH.where as high negative relationship with hardness

Total solids

The total solids value was recorded higher in monsoon of 411.3±13.42 mg/l and lower in summer of 325.6±12.89 mg/l Results indicate that higher total solids was observed in monsoon season lower in summer whereas intermediate in winter season. The overall mean was 373.7±43.81 mg/l and coefficient variation was 11.72. Total solids show high significant positive relationship with Total hardness whereas show high significant negative relationship with pH and significant negative relationship with alkalinity.

Dissolved oxygen (DO)

The DO value was observed maximum in winter of 7.7±0.3 mg/l and minimum was observed in winter of 6.76±0.15 mg/l . Results indicate that higher DO was observed in winter lower in monsoon whereas intermediate value were observed in summer season. The overall mean was 7.35±0.516 mg/l and coefficient variation was 7.02. Demand oxygen show high significant negative relationship with Total hardness.

Biological oxygen demand (BOD)

The BOD value was recorded higher in summer of 5.53±0.25 mg/l and lower in monsoon of 5.13±0.45 mg/l . Results indicate that higher BOD was observed in summer season lower in monsoon whereas intermediate in winter season. The overall mean was 5.36±0.208 mg/l and coefficient variation was 3.88. Biological oxygen demand show high significant positive relationship with DO. Whereas high significant negative relationship with hardness and Total solids.

Chemical oxygen demand (COD)

The COD value was observed maximum in summer of 36.4±2.7 mg/l and minimum was observed in monsoon of 29.53±1.44 mg/l . Results indicate that higher COD was observed in summer lower in monsoon whereas intermediate value were observed in summer season. The overall mean was 32.86±3.43 mg/l and coefficient variation was 10.43. Chemical oxygen demand show high significant positive relationship with pH and BOD. Whereas positive correlation with DO. And show high significant negative relationship with hardness and Total solids.

Transparency (Tra)

The Transparency value was recorded higher in summer of 28±0.2 cm and lower in monsoon of 18.6±0.51 cm. Results indicate that higher Transparency were observed in summer season lower in monsoon whereas intermediate in winter season. The overall mean was 23.36±4.7 cm and coefficient variation was 20.11. Low value of transparency observed in monsoon may be due to influx of rain water from catchment area, less penetration of light and suspended inert particulate matter. Transparency show high significant positive relationship with DO,BOD and COD. And show high significant negative relationship with hardness and pH.

Turbidity (Tur)

The Turbidity value was observed maximum in monsoon of 63.66±10.4 NTU and minimum was observed in winter of 28.66±1.52 NTU. Results indicate that higher Turbidity was observed in monsoon lower in winter whereas intermediate value were observed in summer season. The overall mean was 44.55±7.72 NTU and coefficient variation was 39.77. During the monsoon season higher value of turbidity observed due to influx of rain water from catchment area , washes silts, sand and cloudiness area. Turbidity show positive relationship with water temperature .And show high significant negative relationship with DO, BOD and Transparency.

Electrical conductivity (Ec)

The Electrical conductivity value was recorded higher in summer of 490±7.54 µmhos /cm and lower in winter of 454.3±20.3 µmhos /cm. Results indicate that higher electrical conductivity were observed in summer season lower in monsoon whereas intermediate in winter season. The overall mean was 477.4±20.05 µmhos /cm and coefficient variation was 4.19. Electrical conductivity show significant positive relationship with water temperature, alkalinity and turbidity.

Sulphate

The Sulphate value was observed maximum in summer of 25±5 mg/l and minimum was observed in winter of 18.33±1.52 mg/l . Results indicate that higher Sulphate was observed in summer season lower in winter whereas intermediate value were observed in monsoon season. The overall mean was 21.55±3.34 mg/l and coefficient variation was 15.49. Sulphur come from runoff water of agricultural fields, which contain relatively large quantities of organic and mineral sulphur compounds. Sulphate show high significant positive relationship with water temperature, Alkalinity and electrical conductivity. And significant negative relationship with total solids.

Nitrate

The Nitrate value was recorded higher in monsoon of 0.81±0.01 mg/l and lower in summer of 0.35±0.0 mg/l. Results indicate that higher nitrate were observed in monsoon season lower in summer whereas intermediate in winter season. The overall mean was 0.58±0.23 mg/l and coefficient variation was 39.65. The highest value of nitrate were observed in monsoon may be due to surface runoff and domestic sewage. Nitrate show high significant positive relationship with total hardness, Total solids whereas positive relationship with turbidity. And significant negative relationship with pH, DO, BOD,COD and transparency.

Phosphate

The Phosphate value was observed maximum in monsoon of 0.75±0.026 mg/l and minimum was observed in summer of 0.27±0.025 mg/l. Results indicate that higher phosphate was observed in monsoon lower in summer whereas intermediate value were observed in winter season. The overall mean was 0.48±0.24 mg/l and coefficient variation was 50. Phosphate show high significant positive relationship with Total hardness, Total solids and nitrate , whereas significant positive relationship with Turbidity. And show high significant negative relationship with DO,BOD, COD, Tra ,whereas negative relationship with pH and turbidity.

Chloride

The Chloride value was recorded higher in summer of 81.36±3.84 mg/l and lower in monsoon of 43.36±2.89 mg/l . Results indicate that higher chloride were observed in summer season lower in monsoon whereas intermediate in winter season. The overall mean was 115.9±34.82 mg/l and coefficient variation was 30.06. The chloride level was observed lower in monsoon season due to dilution. Chloride show high significant positive relationship with water temperature, pH, sulphate and electrical conductivity, whereas show negative relationship with pH.

Salinity

The salinity value was observed maximum in summer of 148.9±6.41 and minimum was observed in winter of 79.5±5.31. Results indicate that higher salinity were observed summer lower in winter whereas intermediate value were observed in monsoon season. The overall mean was 115.9±34.82 and coefficient variation was 30.06. Salinity show high significant positive relationship with water temperature, pH, sulphate and electrical conductivity, whereas show negative relationship with pH.

IV. Conclusions

- The present study show detailed physico-chemical characteristics and quality of water in Shringverpur. The summer, monsoon and winter seasons shown different seasonal fluctuations in various physico-chemical parameters.
- The Correlation coefficient indicates positive and negative significant correlation of physico-chemical parameters with each other. Positive correlation means one parameter directly proportional to other parameter (i.e, one parameter **α** other parameter) and negative correlation means (one parameter 1/α other parameter) one parameter inversely to other parameter increases with other parameters and negative correlation mean one parameter increase with other parameter decrease.The value of correlation coefficient helps in selecting the proper treatment to minimize the contamination of the Ganga river water.
- There is also need of increasing awareness among the people to maintain the river water at their highest quality and purity level.To improve the quality of water there should be continuous monitoring of pollution level and methods should be applied for removing water pollution in the holy place Shringverpur at Allahabad (U.P.) India.Monitoring of the water quality of sampling sites of Shringverpur as well as the River Ganga should be done at regular interval.

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